

IN THE CLAIMS

Please cancel Claims 1-12, 16-18, 22, 23, and 25, and amend the remaining claims as follows:

13. (Amended) A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first refrigeration system is operated by

(1) compressing a first gaseous refrigerant;

(2) cooling and at least partially condensing the resulting compressed refrigerant;

(3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;

(4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and

(5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1);

[The method of Claim 11] wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third [recirculating] refrigeration system [circuit].

14. (Amended) The method of Claim 13 wherein the third [recirculating] refrigeration system [circuit] utilizes a single component refrigerant.

15. (Amended) The method of Claim 13 wherein the third [recirculating] refrigeration system [circuit] utilizes a mixed refrigerant comprising two or more components.

19. Amended) A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second recirculating refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

[The method of Claim 16] wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerants provided by a third [recirculating] refrigeration system [circuit].

20. (Amended) The method of Claim 19 wherein the third [recirculating] refrigeration system [circuit] utilizes a single component refrigerant.

21. (Amended) The method of Claim 19 wherein the third [recirculating] refrigeration system [circuit] utilizes a mixed refrigerant which comprises two or more components.

24. (Amended) A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first refrigerant system is operated by

(1) compressing a first gaseous refrigerant;

(2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;

(3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide refrigeration in the first temperature range and yield a first vaporized refrigerant;

(4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and

(5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1);

[The method of Claim 23] wherein vaporization of the resulting liquid in (4) is effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and wherein the second vaporized refrigerant is compressed before combining with the first vaporized refrigerant.

26. (Amended) A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more

refrigerant components and provides refrigeration in a first temperature range;
and

(b) a second refrigeration system which provides refrigeration in a
second temperature range by work expanding a pressurized gaseous
refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the
pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled
gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold
refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second
temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second
gaseous refrigerant of (1);

[The method of Claim 16] wherein the feed gas is natural gas, the resulting liquefied natural gas stream is flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor is used to provide the second gaseous refrigerant in the second refrigerant system [circuit].

Please add the following new claims:

27. (New) A method for the liquefaction of a feed gas which comprises providing at
least a portion of the total refrigeration required to cool and condense the feed gas by
utilizing

(a) a first refrigeration system comprising at least one recirculating
refrigeration circuit, wherein the first refrigeration system utilizes two or more
refrigerant components and provides refrigeration in a first temperature range;
and

(b) a second refrigeration system which provides refrigeration in a
second temperature range by work expanding a pressurized gaseous
refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein at least a portion of the pressurized gaseous refrigerant in (2) is entirely cooled separately from cooling of the feed gas.

28. (New) The method of Claim 27 wherein all of the pressurized gaseous refrigerant is cooled separately from cooling of the feed gas.

29. (New) The method of Claim 27 wherein a portion of the pressurized gaseous refrigerant is cooled by indirect heat exchange with the at least one recirculating refrigeration circuit of (a).

30. (New) The method of Claim 27 wherein the first refrigeration system comprises a mixed component, pure component, and/or a cascaded vapor recompression refrigeration system.

31. (New) An apparatus for the liquefaction of a feed gas comprising

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range, wherein at least a portion of the first temperature range is between -40°C and -100°C ; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream, wherein at least a portion of the second temperature range is below -100°C ;

wherein the first refrigeration system comprises

(1) compression means for comprising a first gaseous refrigerant;

(2) heat exchange means for cooling and at least partially condensing the resulting compressed refrigerant;

(3) means for reducing the pressure of the resulting at least partially condensed compressed refrigerant ;

(4) heat exchange means for vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and

(5) means for recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1);

and wherein the apparatus comprises additional heat exchange means to provide at least a portion of the cooling of (2) by indirect heat exchange with one or more additional vaporizing refrigerant streams and a third refrigeration system to provide the one or more additional vaporizing refrigerant streams.

32. (New) The apparatus of Claim 31, wherein the second refrigeration system comprises

(6) compression means for compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant;

(7) heat exchange means for cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(8) expansion means for work expanding the cooled gaseous refrigerant to provide the cold refrigerant;

(9) heat exchange means for warming the cold refrigerant to provide refrigeration in the second temperature range; and

(10) means for recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (6).

33. (New) The apparatus of Claim 31, wherein at least one of the heat exchange means in the first and second refrigeration systems comprises a wound coil heat exchanger.

34. (New) An apparatus for the liquefaction of a feed gas comprising

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit utilizing two or more refrigerant components and providing refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range having a lowest temperature less than the lowest temperature in the first temperature range;

wherein the second refrigeration system comprises

(1) compression means for compressing the second gaseous refrigerant to provide the pressurized gaseous refrigerant;

(2) heat exchange means for entirely cooling at least a portion of the pressurized gaseous refrigerant separately from cooling of the feed gas to yield at least a portion of the cooled gaseous refrigerant;

(3) expansion means for work expanding the cooled gaseous refrigerant to provide the cold refrigerant;

(4) heat exchange means for warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) means for recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

35. (New) The apparatus of Claim 34 wherein the heat exchange means of (2) cools all of the pressurized gaseous refrigerant separately from cooling of the feed gas.

36. (New) The apparatus of Claim 34 wherein the first refrigeration system comprises

(A) compression means for compressing the first gaseous refrigerant;

(B) heat exchange means for cooling and at least partially condensing the resulting compressed refrigerant;

(C) pressure reducing means for reducing the pressure of the resulting at least partially condensed compressed refrigerant;

(D) heat exchange means for vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield the vaporized refrigerant; and

(E) means for recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (A).

37. (New) The apparatus of Claim 34 wherein at least a portion of the cooling in the heat exchanger of (2) is provided by indirect heat exchange by warming the cold refrigerant in (4).

38. (New) The apparatus of Claim 38 wherein at least one of the heat exchange means of the first and second refrigeration systems comprises a wound coil heat exchanger.